

# NavCom Technology, Inc.

A John Deere Company

## Satellite Precise Positioning for Agriculture and Farming

by

Dr. Peter Williams  
Director, Advanced Programs

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*“Making the Rural Connection”*



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# Who We Are

## John Deere & NavCom

- John Deere, Ag Management Solutions supplies innovative solutions for advanced “Precision Farming” systems
- NavCom has evolved from a provider of contract engineering services to a rapidly growing system integration company
- Located in Southern California
- NavCom began developing GPS based Precise Positioning systems for Deere in 1994



*NavCom became a John Deere Company in  
November 1999*



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# What NavCom Does for Deere

- **Provide a center of excellence** in precise positioning and wireless data communications to support Deere SBU's
- **Ensure Deere is first and best** in the provision of advanced technology options for its major products
- **Add shareholder value** through the development of new business opportunities for non-traditional Deere markets



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# The need for Precise Positioning in Farming today

## ■ Precision Farming

- Allows mapping of crop yields to create data base for future crop management
- Precise application of fertilizers and seeds to optimize yield
- Improved yield reduces cost and eliminates harmful run off due to over application

## ■ Automatic Vehicle Guidance

- Assists the operator to maintain precise crop rows during planting and harvesting
- Permits automatic guidance of vehicles to further improve operator performance.



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# The StarFire System

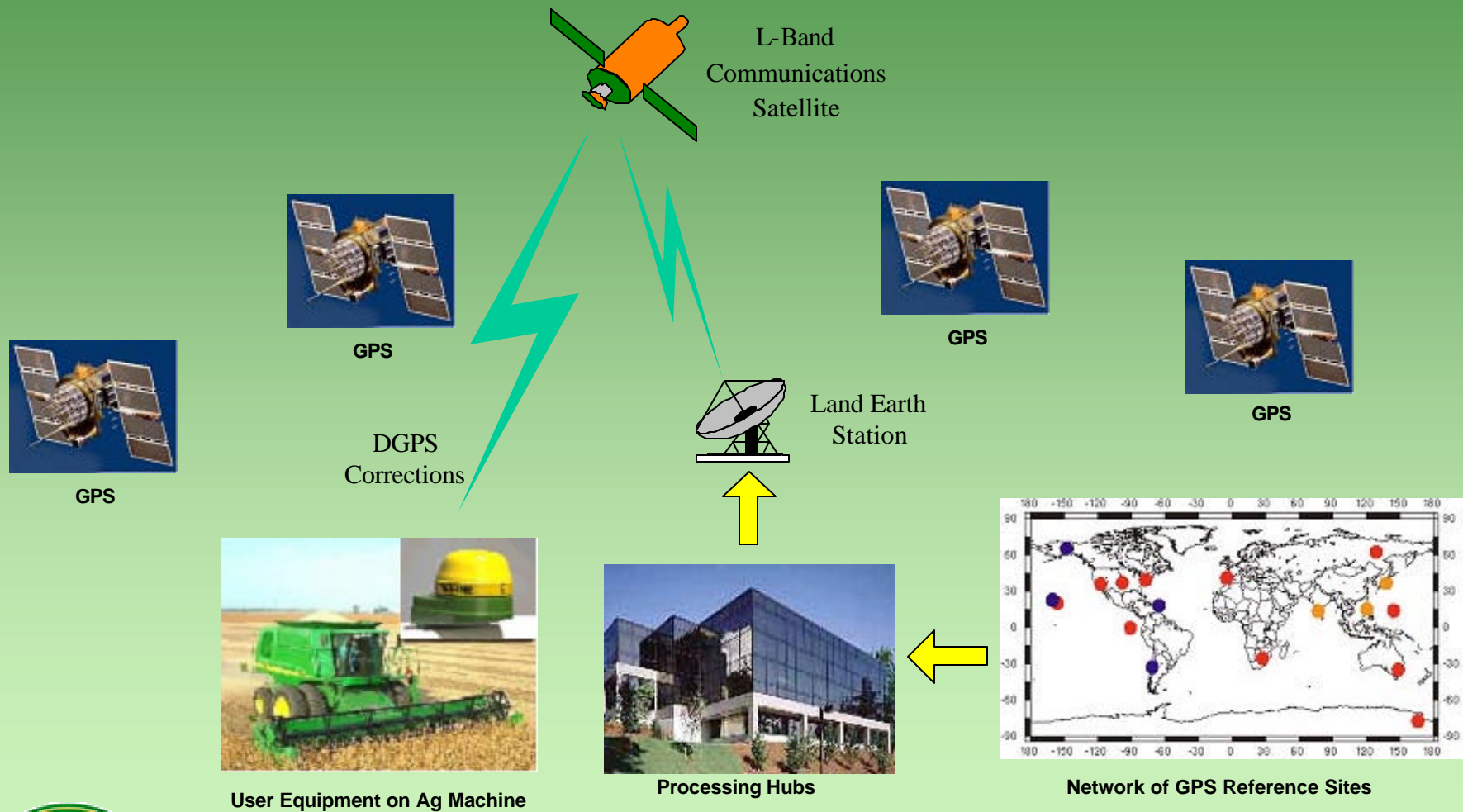


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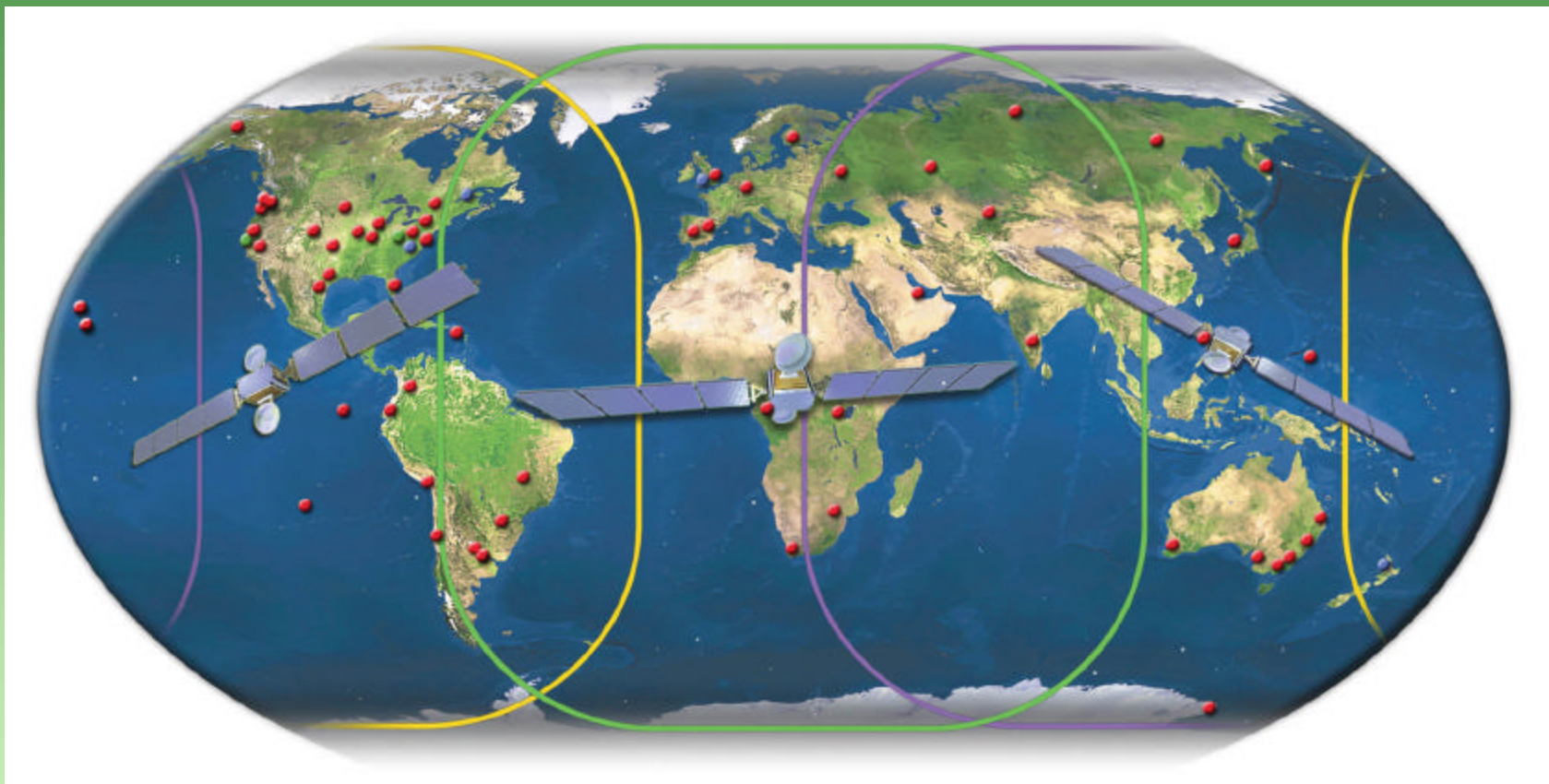
# StarFire Network Overview






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# StarFire Global Reference Network



-  **GPS Dual Frequency Reference Stations**
-  **Data Processing Hubs**
-  **Satellite Uplink Stations**



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# Monitors

- One or more StarFire user receivers are located at all NCT reference sites in the global *StarFire* network.
- These Monitors receive the broadcast correction stream, perform differential GPS navigation and report their positioning results in real time.
- Automated alerts are generated if problems are noted, and performance graphs are posted to the secure StarFire web site every few minutes.
- Performance measures include:
  - Navigation Accuracy
  - Pass-to-Pass Accuracy



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# NavCom & Deere team with NASA/JPL

- NavCom's arrangement with NASA/JPL included:
  - License to use the JPL Real Time GIPSY (RTG) algorithms and software.
  - Use of the JPL dual frequency GPS Ground Network (GGN)
- NavCom has integrated the NASA/JPL GGN data into its own global network of reference stations
- NavCom has continued to develop and extend the global correction algorithms in the implementation of the current SBAS system.
- *StarFire* now offers a unique global 10cm service via Inmarsat Satellites
- Future Developments:
  - Full GPS/INS integration for terrain compensation and improved performance under foliage
  - Return link to permit short message service (SMS)



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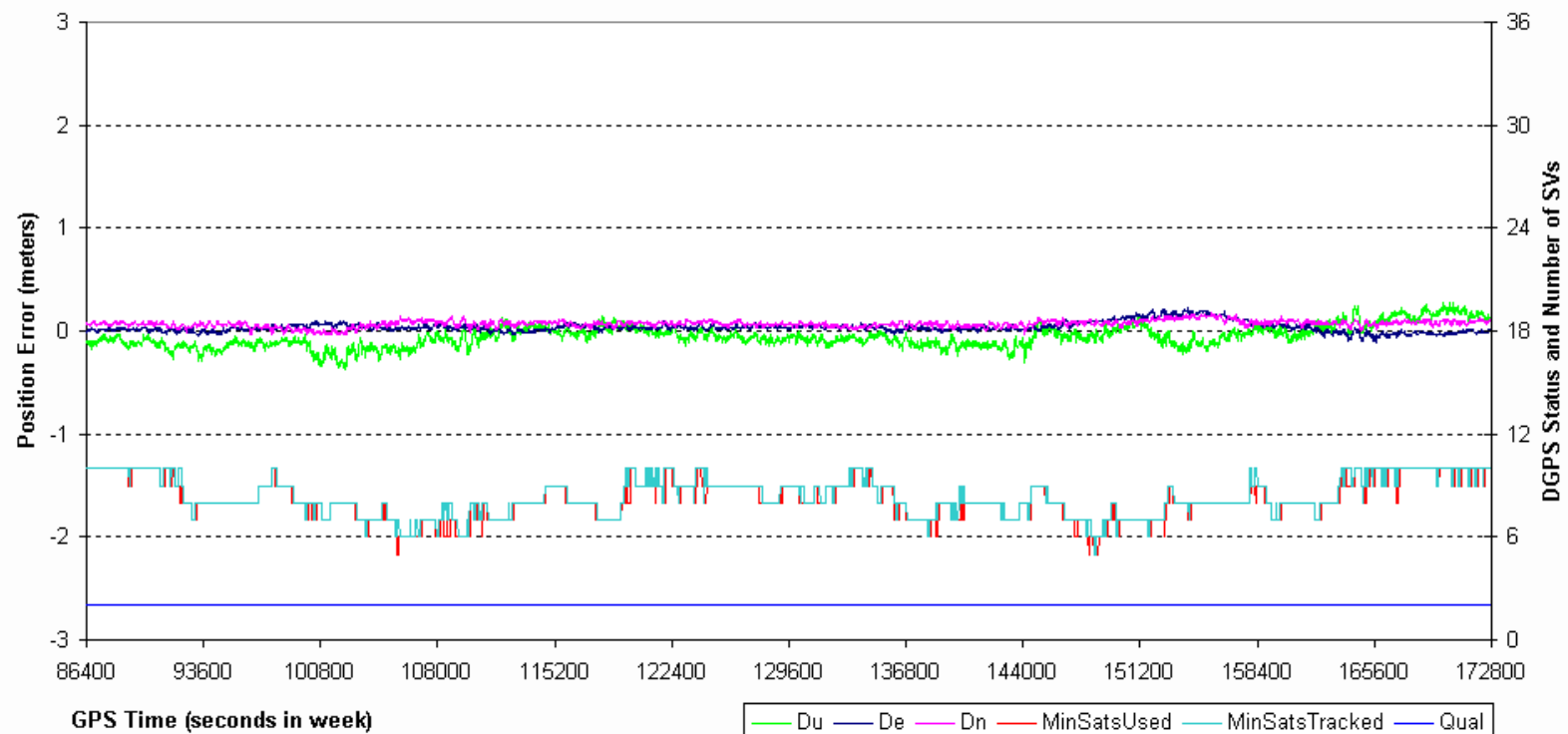


# Horizontal Positioning Accuracy

## Using the JPL RTG Corrections with NCT Extended Kalman Filter

12/1/2003			
	East	North	Up
Ave.(m)	0.038	0.070	-0.054
Sigma(m)	0.046	0.030	0.104
95 % (m)	0.140	0.110	
SW:	6.00LT	SN:	250513

Starfire Monitor Receiver  
Melbourne (AU) \_ RTG



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# Rugged *StarFire*<sup>TM</sup> Sensor



*... decimeter Accuracy  
in real time worldwide*

- Rugged and light weight position sensor combines GPS receiver and L-band demodulator
- Built in tri-band antenna for GPS and L-band signals
- External power input
- Automatically accepts WAAS/EGNOS data
- Flexible user interface including output of standard NMEA messages



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# Yield Mapping

Many crops (wheat, corn, etc.) are harvested with large machines called combines.

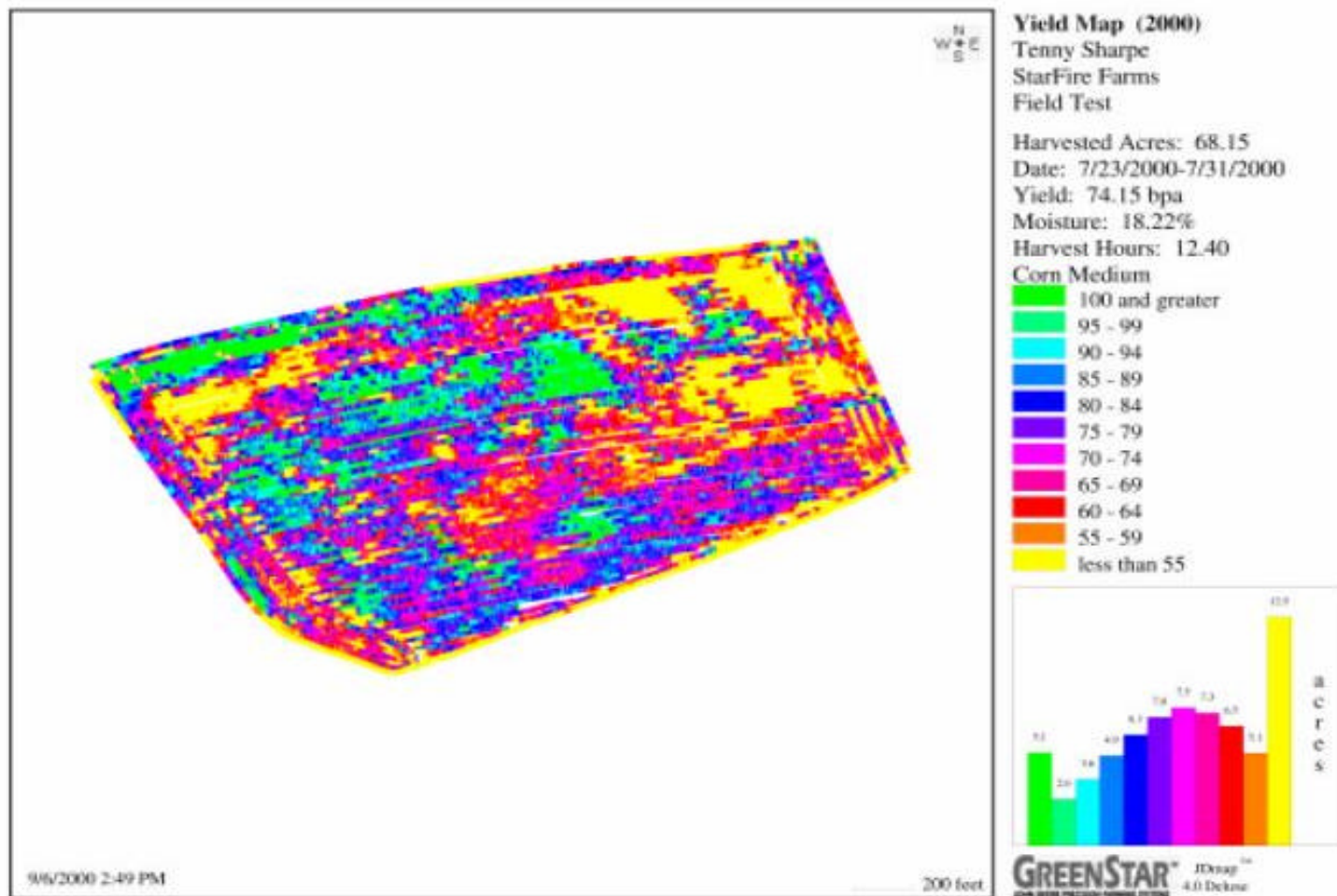
In the last few years, increasing numbers of these machines have been equipped with sensors and computers that simultaneously measure and record crop yield and accurate position in real time as the crop is being harvested.



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# Automatic Steering

Many of the field operations involved in row crop production (planting, spraying, cultivating, etc.) involve steering a tractor and towed implement along a straight line with as little deviation as possible.

These operations require a skilled driver and cumbersome visual aids. They are also limited to good visibility conditions. All of which affects productivity.



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# Automatic Steering

Precise navigation and positioning information from sensors such as GPS combined with computer based control algorithms enable systems to be designed to meet even the most challenging automatic steering requirements.



This row crop cultivation operation requires one inch accuracy from pass to pass otherwise crop plants will be destroyed instead of weeds.



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# AMS GreenStar AutoTrac Advantages

- **Reduce Operator Fatigue**
  - More comfortable working hours
  - Increased awareness of machine functions
- **Optimize Machine Efficiency**
  - Operate at faster field speeds
  - Reduce per acre fuel consumption
  - Reduce overlap on implements and sprayers
- **Increase Yield**
  - Cover more acres with fewer hours of operation
  - Centralize compaction due to planned traffic patterns on fields
  - More accurate placement of agronomic inputs such as fertilizer and herbicides



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# The many New Applications of *StarFire* GPS Technology



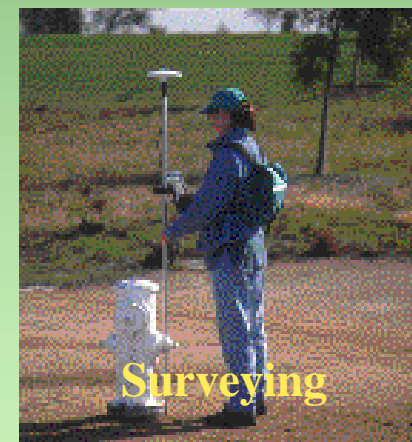
**Offshore Operations**



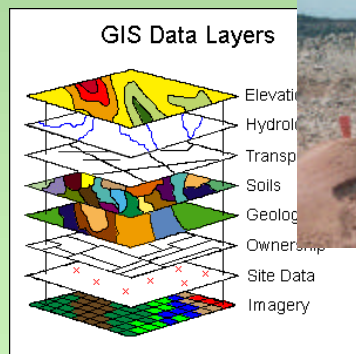
**Agriculture**



**Machine Control**



**Surveying**



**GIS**



**Commercial Marine**



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## .....in Summary

- Integrated Satellite Navigation (GPS) and Communications systems (Inmarsat) have enabled the development of precise positioning systems which contribute to improved farming operations:
  - Yield mapping
  - Steering Aids for Parallel Tracking
  - Automatic Steering for Ag vehicles
- Future developments will improve accuracy add capability to greatly enhance agricultural efficiency, cost and reliability



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